



Maine Department of Transportation Transportation Research Division



Technical Report 02-2 *Using Foamed Asphalt as a Stabilizing Agent in Full Depth Reclamation of Route 8 in Belgrade*

Interim Report - First Year, December 2003

Transportation Research Division

Using Foamed Asphalt as a Stabilizing Agent in Full Depth Reclamation of Route 8 in Belgrade

Introduction

Maine has a variety of soil types throughout the state. Most of these soil types degrade rapidly and have poor stability. To eliminate the cost of supplying quality road base material from a distant source and increase the stability of existing soils, the Maine Department of Transportation (MDOT) has been requiring contractors to rehabilitate roads using the full depth reclamation process.

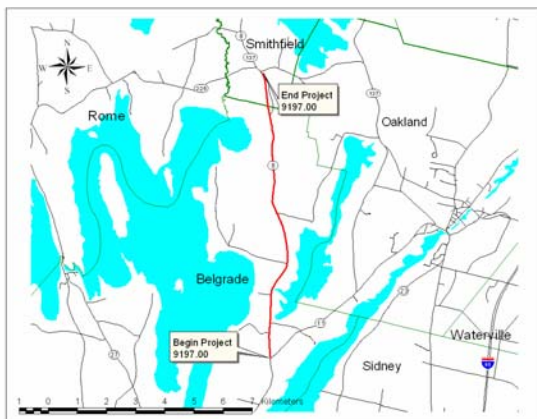
Full depth reclamation involves milling the existing bituminous pavement plus a portion of the base material. The milled material is then graded and compacted. Traffic can use the roadway until a bituminous base and wearing surface is applied.

In addition to using full depth reclaimed material, MDOT has been experimenting with adding a number of stabilizing agents to virgin or recycled base materials to increase stability. Some of the stabilizing agents include cement, emulsion and calcium chloride.

Foamed Asphalt is another stabilizing agent. This is a mixture of air, water and hot asphalt. Cold water is introduced to hot asphalt causing the asphalt to foam and expand by more than 10 times its original volume. During this foaming action the asphalt has a reduced viscosity making it much easier to mix with aggregates. A specialized piece of equipment mills the existing bituminous pavement and base material and introduces Foamed Asphalt all in one process. The material is then graded and compacted. Traffic can operate on the stabilized base until a hot mix asphalt base and wearing surface is applied.

This paper will evaluate the performance of the experimental application.

Project Description



Federal project number STP-9197(00)X on State Route 8 between the towns of Belgrade and Smithfield was selected for Foamed Asphalt stabilization. This is a Highway Improvement project beginning at the intersection of State Route 11 in Belgrade and extending northerly 10.15 km (6.31 mi). This project has a high occurrence of frost deformation with rut depths of 18 mm (0.7 in) in areas and International Roughness Index values as high as 3.17 m/km (201 in/mi). Sections of the project were built to state standards and are scheduled for resurfacing only. Other sections are scheduled for either Full Reconstruction, Full Depth Reclamation with Variable Depth Gravel or Full Depth Reclamation with Foamed Asphalt.

Preliminary Data Collection

A detailed overview of preliminary data collection can be reviewed in Technical Report 02-2 “Using Foamed Asphalt as a Stabilizing Agent in Full Depth Reclamation of Route 8 in Belgrade” Construction Report, February 2002.

Foamed Asphalt Mix Design

Foamed Asphalt Mix Design procedures can also be reviewed in Technical Report 02-2 “Using Foamed Asphalt as a Stabilizing Agent in Full Depth Reclamation of Route 8 in Belgrade” Construction Report, February 2002.

Construction

Construction and Treatment details as well as typical cross-sections can be reviewed in Technical Report 02-2 “Using Foamed Asphalt as a Stabilizing Agent in Full Depth Reclamation of Route 8 in Belgrade” Construction Report, February 2002.

Table 1 contains station limits for each treatment within the project.

Table 1 Project treatments by section (not to scale).

1+160	1+400	1+490	1+640	2+680	2+795	3+460	3+527	3+600	3+700	3+820	4+000	4+130	4+205	4+380	4+900 *	6+860	7+600	8+720	9+520	11+280
SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF	SURF
SHIM	60 B	60 B	40 B	SHIM	60 B	60 B	60 B	60 B	60 B	60 B	60 B	60 B	60 B	SHIM	40 B	SHIM	40 B	FDRBS	SHIM	
	FDR	RECON	FDRBS		FDRVDG	RECON	FDR	RECON	FDR	FDRVDG	FDR	RECON	FDRVDG		FDRBS		FDRBS			

SURF	= 40 mm of 12.5 mm HMA Surface	RECON	= Full Depth Reconstruction
SHIM	= Variable Depth 9.5 mm HMA Shim	FDR	= Full Depth Reclamation
40 B	= 40 mm of 12.5 mm HMA Base	FDRVDG	= Full Depth Reclamation w/ Variable Depth Gravel
60 B	= 60 mm of 12.5 mm HMA Base	FDRBS	= Full Depth Reclamation w/ Bituminous Stabilizer

* No crusher dust between stations 6+445 and 6+525

Cost Summary

Table 2 contains a Cost Summary for each treatment. As expected the HMA Overlay has the lowest cost and Full Depth Reconstruction has the highest cost.

The Full Depth Reclamation without Stabilizer and Asphalt Stabilized Base without HMA Base are very similar in costs. Evaluation of these sections over the five-year period will determine which treatment is cost effective.

Sections treated with Full Depth Reclaimed material plus Variable Depth Gravel and Asphalt Stabilized Base with HMA Base are also similar in costs. Once again evaluation of these sections will determine which treatment is cost effective.

Table 2 Treatment cost summary (cost per square meter)

Treatment	40 mm HMA Surface	Shim ¹	40 mm HMA Base	60 mm HMA Base	CIPR	VDG ²	Excavation	ASCG ³	Stabilized Subbase	Total Cost
HMA Overlay	3.42	2.93								6.35
FDR	3.42			5.13	1.33					9.88
FDR + VDG	3.42			5.13	1.33	5.04				14.92
Full Reconstruction	3.42			5.13			5.04	8.29		21.88
Stabilized Base w/HMA Base	3.42		3.42						8.32	15.16
Stabilized Base wo/HMA Base	3.42								8.32	11.74

1 Average depth of 35 mm

2 Variable Depth Gravel (average depth of 360 mm)

3 Aggregate Subbase Course Gravel (650 mm depth)

Project Evaluation

This project will be evaluated over a period of five years. Three areas were demarcated for evaluation, one control and two test sections. Performance of each test section will be compared to the control section and summarized in the TEST SECTION ANALYSIS portion of this report. Data collection will include FWD deflections to monitor changes in structural integrity of the recycled and stabilized base. Surface evaluations will include roughness, rutting, and cracking. Cores were extracted from the two test sections to measure density, resilient modulus, and grain size of the Foamed Asphalt.

In addition to evaluating the control and test sections, FWD tests will be collected every 100 meters to monitor structural changes within each treatment and the ARAN will test the entire project for rut depth and roughness. A visual evaluation of the entire project will be conducted in late winter/early spring of each year to locate areas that have frost movement. Results of these tests are summarized in the PROJECT ANALYSIS section of this report.

Test Section Analysis

It was important to select a Control Section that closely compares to the Foamed Asphalt treated sections.

A Control Section located between stations 3+700 and 3+820 was constructed using full depth reclaimed material for the subbase much like the Foamed Asphalt sections only without bituminous stabilizer. Caution was taken to select an area that has no variable depth gravel added to the recycled subbase. The surface is paved with 60 mm of 12.5 mm Hot Mix Asphalt (HMA) Base and 40 mm of 12.5 mm HMA Surface.

Test Section One is located between stations 4+980 and 5+180. The reclaimed subbase is treated with Foamed Asphalt. The surface is paved with 40 mm of 12.5 mm HMA Base and 40 mm of 12.5 mm HMA Surface.

Test Section Two is located between stations 9+100 and 9+300. This section has Foamed Asphalt stabilized subbase and is surfaced with 40 mm of HMA Surface with no HMA Base.

Test Section Core Sample Properties

Three 150 mm (6 in) diameter cores were extracted from each test section on September 27, 2001 to determine density, resilient modulus, asphalt content, and grain size of the Foamed Asphalt treated base. Core number 2 was destroyed during extraction from the core bit. The remaining cores were intact and

very stable. Depth of Foamed Asphalt treatment varied from 165 to 202 mm (6.5 to 8.0 in). Tests will be completed at Worcester Polytechnic Institute (WPI). Table 3 contains core locations and descriptions.

Unfortunately, the cores cut on September 27 were damaged en-route to the WPI lab. Another set of six cores were cut in the same locations in May of 2002, eight months after project completion.

Table 3 Core Locations

Core	Station	Offset	Test Section
1	9+277	1.8 m Left	Section 2
2	9+177	1.8 m Right	Section 2
3	9+216	1.8 m Right	Section 2
4	5+141	1.8 m Left	Section 1
5	5+090	1.8 m Right	Section 1
6	5+031	1.8 m Left	Section 1

The HMA surface and base were separated from the cores and the Foamed Asphalt portion of each core was sliced into four 50 mm (2 in) layers to check variations within each core. Only four of the six cores could be sliced successfully. Core number 1 was sliced into four 50 mm (2 in) layers, core number 2 and 3 had two 50 mm (2 in) layers sliced from the top half of each core, and core number 5 had a 50 mm (2 in) slice from the top layer only. The bottom section of many of the cores did not remain intact indicating the lower portion of the stabilized base may not have been compacted properly in the field. Table 4 contains a summary of test results for density, resilient modulus, and asphalt content.

Densities in the top 50 mm (2 in) layer ranged from 1996 to 2133 kg/m³ (124.6 to 133.2 pcf) with an average of 2048 kg/m³ (127.9 pcf) and standard deviation of 62 kg/m³ (3.9 pcf).

The second 50 mm (2 in) layer had densities ranging from 1935 to 2140 kg/m³ (120.8 to 133.6 pcf) with an average of 2026 kg/m³ (126.5 pcf) and standard deviation of 104 kg/m³ (6.5 pcf).

The third and bottom layer of core number 1 had densities of 1995 kg/m³ (124.5 pcf) and 2013 kg/m³ (125.7 pcf) respectively. This suggests that density can be achieved in the lower portion with proper construction.

Top layer Resilient Modulus had a range of 599 to 1899 MPa (86.9 to 275.4 ksi) with an average of 1244 MPa (108.4 ksi) and standard deviation of 565 MPa (81.9 ksi).

Second layer resilient modulus ranged from 748 to 1196 MPa (108.5 to 173.5 ksi) with an average of 1028 MPa (149.1 ksi) and standard deviation of 244 MPa (35.4 ksi).

Third layer and bottom layer resilient modulus was 2997 MPa (434.6 ksi) and 494 MPa (71.6 ksi) respectively. Low readings on the second and bottom layer of core #1 may be attributed to the amount of 50 mm stones in these layers. Large stones do not coat well with Foamed Asphalt thus reducing material stiffness. It's important to reduce the amount of coarse material in the Foamed Asphalt mix to achieve structural integrity.

Seven of the nine core layers were tested for asphalt content by ignition testing method. The results varied from 6.7 to 9.1 percent with an average of 8.3 percent and standard deviation of 0.79 percent. Variable thickness of in-situ HMA within the project may contribute to the wide range of asphalt content.

Four layers were tested for grain size; the top layer of core number 5, second layer of core number 2, and the third and bottom layer of core number 1. Results of the sieve analysis are displayed in Table 5. Data shows little change in grain size between layers.

Table 4 Density, Resilient Modulus, and Asphalt Content Summary

Density, kg/m³						
Core #	1	2	3	5	Layer Average	Layer Standard Deviation
Top 50 mm	2009	2055	2133	1996	2048	62
Second 50 mm	1935	2003	2140		2026	104
Third 50 mm	1995				1995	
Bottom 50 mm	2013				2013	
Core Average	1988	2029	2137	1996		
Core Standard Deviation	36	37	5			
Resilient Modulus, MPa						
Core #	1	2	3	5	Layer Average	Layer Standard Deviation
Top 50 mm	1477	1003	1899	599	1245	565
Second 50 mm	748	1140	1196		1028	244
Third 50 mm	2997				2997	
Bottom 50 mm	494				494	
Core Average	1429	1071	1548	599		
Core Standard Deviation	1125	97	497			
Asphalt Content, %						
Core #	1	2	3	5	Layer Average	Layer Standard Deviation
Top 50 mm	NA	8.1	NA	8.9	8.5	0.57
Second 50 mm	8.2	9.1	6.7		8.0	1.21
Third 50 mm	8.6				8.6	
Bottom 50 mm	8.5				8.5	
Core Average	8.4	8.6	6.7	8.9		
Core Standard Deviation	0.21	0.71				

Table 5 Sieve Analysis Summary (percent passing)

Sieve Size	Core Number / Layer				Average	Std. Dev.
	5 / Top	2 / Second	1 / Third	1 / Bottom		
19	100.0	100.0	100.0	100.0	100.0	0.00
12.5	99.5	96.8	98.9	95.8	97.8	1.74
9.5	99.1	95.7	95.3	94.6	96.2	2.00
4.75	91.3	88.6	87.3	88.2	88.9	1.72
2.36	78.8	79.3	76.1	79.5	78.4	1.58
1.18	64.4	66.6	61.9	65.3	64.6	1.98
0.6	44.7	45.8	38.6	43.6	43.2	3.18
0.3	23.9	23.4	19.1	21.6	22.0	2.17
0.15	12.7	12.7	10.1	11.8	11.8	1.23
0.075	7.1	7.4	5.8	7.0	6.8	0.70

Test Section FWD Analysis

Pavement deflections were collected in the control and each test section on July 16, 2002. Table 6 contains a summary of processed FWD data.

All but one of the Overlay Structural Number values in the Control Section has a negative number indicating the Existing Structural Numbers are not adequate for a twenty year design life. This is due to

changes that were made to the Proposed Treatment List prior to construction. Station 3+700 to 3+820 was scheduled for Foamed Asphalt. The list was updated to eliminate a number of small areas scheduled for Foamed Asphalt and treat them with Full Depth Reclamation.

Test Section 1 has two areas that have less than adequate Existing Structural Numbers. Station 5+000 is slightly lower and station 5+141 is noticeably lower than the Future Traffic Structural Number. The Existing Pavement Modulus is low for station 5+141 possibly contributing to the low Overlay Structural Number. The remaining test sites are structurally adequate for a twenty year design life.

Although Test Section 2 has two negative Overlay Structural Numbers, the Existing Structural Numbers are close enough to the Future Traffic Structural Numbers that the test section meets the twenty year design life.

Test Section Ride Analysis

Smoothness measurements were collected on November 8, 2002 utilizing the departments Automatic Road Analyzer (ARAN). This is an ASTM Class II profile-measuring device that is capable of accurately measuring roadway smoothness. The ARAN measures the lateral profile of each wheel path every 50 mm (2 in) then averages those measurements every 20 meters (66 ft). Smoothness is displayed in International Roughness Index (IRI) units. Table 7 contains a range of IRI values and descriptions for each range.

Table 6 Test Section FWD Data Summary, Test Date 7-16-2002

Station (meters)	Existing Structural Number (mm)	Future Traffic Structural Number (mm)	Overlay Structural Number (Existing – Future)	Existing Pavement Modulus (kPa)	Subgrade Resilient Modulus (kPa)	Pavement Depth (mm)	Combined Pavement / Gravel Depth Used for Calculation (mm)
Control Section							
3+700 NBL	137	100	37	439572	38823	100	750
3+725 SBL	91	105	-14	863145	33291	100	400
3+750 NBL	82	107	-25	632742	31750	100	400
3+800 NBL	85	111	-26	699559	28144	100	400
3+820 SBL	94	101	-7	938925	37557	100	400
Test Section 1							
5+000 NBL	108	114	-6	1143594	26451	280	430
5+031 SBL	104	102	2	1027719	35931	280	430
5+090 NBL	124	102	22	1749055	36429	280	430
5+100 NBL	111	96	15	1237371	43898	280	430
5+141 SBL	97	111	-14	829949	28520	280	430
Test Section 2							
9+100 NBL	100	102	-2	736442	36042	240	460
9+177 NBL	102	97	5	789276	42276	240	460
9+200 NBL	108	97	11	947529	42172	240	460
9+216 NBL	99	100	-1	725557	38349	240	460
9+277 SBL	105	105	0	864102	33217	240	460
9+300 NBL	103	91	12	807284	50900	240	460

After a year of traffic, Test Section 1 with Foamed Asphalt and 80 mm (3 in) of HMA has the best ride with an IRI of 1.03. The Control Section with unstabilized full depth reclaimed base and 100 mm (4 in) of HMA and Test Section 2 with Foamed Asphalt and 40 mm (1.6 in) of HMA have somewhat equal smoothness values at 1.22 and 1.25 respectively. These values represent a very smooth ride and are typical of one year old newly constructed highways. Table 8 contains a summary of IRI values for each experimental section.

Table 9 contains a statistical comparison of IRI values between each section using Tukey's Studentized Range. Results show that Test Section 2 is significantly rougher than Test Section 1. This could be attributed to the reduced thickness of HMA in Test Section 2.

Table 7 IRI Range and Descriptions

IRI (Meters/Kilometer)	IRI (Inches/Mile)	Verbal Description
1.02 - 1.57	65 - 99	Comfortable ride at 105/65 kph/mph. No noticeable potholes, distortions, or rutting. High quality pavement.
1.58 - 3.15	100 - 199	Comfortable ride at 88/55 kph/mph. Moderately perceptible movements induced by occasional patches, distortions, or rutting.
3.16 - 4.73	200 - 299	Comfortable ride at 72/45 kph/mph. Noticeable movements and swaying induced by frequent patches and occasional potholes. Some distortion and rutting.
Greater than 4.73	Greater than 299	Frequent abrupt movements induced by many patches, distortions, potholes, and rutting. Ride quality greatly diminished.

Table 8 Test Section 2002 International Ride Index Summary

Treatment	High IRI	Low IRI	Avg. IRI	Count	SD
Control	2.75	0.81	1.22	24	0.526
Test Section 1	1.49	0.70	1.03	40	0.194
Test Section 2	2.28	0.80	1.25	40	0.316

Table 9 Test Section Statistical Analysis of 2002 IRI Data

The SAS System
The GLM Procedure

Class Level Information

Class	Levels	Values
Group	3	Control, TS1, TS2

Number of observations 104

Tukey's Studentized Range (HSD) Test for TESTs
NOTE: This test controls the Type I experimentwise error rate.

Alpha	0.05	Error Mean Square	0.115932
Error Degrees of Freedom	101	Critical Value of Studentized Range	3.36410

Comparisons significant at the 0.05 level are indicated by ***.

Group	Difference	Simultaneous 95%
<u>Comparison</u>	<u>Between Means</u>	<u>Confidence Limits</u>
TS2 - Control	0.03708	-0.17204 0.24621
TS2 - TS1	0.22300	0.04189 0.40411 ***
Control - TS2	-0.03708	-0.24621 0.17204
Control - TS1	0.18592	-0.02321 0.39504
TS1 - TS2	-0.22300	-0.40411 -0.04189 ***
TS1 - Control	-0.18592	-0.39504 0.02321

Test Section Rut Depth Analysis

Rut depth measurements were collected on Oct 8, 2002 utilizing the ARAN test vehicle. Rut depth measurements are collected to the nearest millimeter in each wheel path at 20 m (66 ft) intervals. Table 10 contains a summary of ARAN Rut Depth measurements.

All experimental test sections have typical rutting after one year's exposure to traffic. Test results disclose that both bituminous stabilized Test Sections had less rutting than the Control Section. Test Section 1, with a total HMA depth of 80 mm (3 in), has the lowest amount of rutting with an average rut depth of 4.88 mm (0.19 in). Test Section 2, with a total HMA depth of 40 mm (1.6 in), has an average rut depth of 5.03 mm (0.20 in). The Control Section, with 100 mm (4 in) total depth of HMA, has the greatest rut depth at an average of 5.46 mm (0.21 in).

Table 10 Test Section 2002 Rut Depth Summary

Treatment	High Rut	Low Rut	Avg. Rut	Count	SD
Control	7.25	4.00	5.46	24	0.868
Test Section 1	6.50	4.00	4.88	40	0.635
Test Section 2	6.50	4.00	5.03	40	0.630

A statistical comparison of Rut Depth measurements is displayed in Table 11. Comparisons reveal that the Control section has significantly deeper ruts than Test Section 1 and 2. Foamed asphalt may be reducing the amount of rutting in the two Test Sections.

Test Section Visual Analysis

A visual inspection was completed on October 29, 2002. After one year of traffic the test sections show no signs of cracking, deformation, or segregation and the centerline joint is very tight.

Table 11 Test Section Statistical Analysis of 2002 Rut Depth Data

The SAS System

The GLM Procedure

Class Level Information

<u>Class</u>	<u>Levels</u>	<u>Values</u>
Group	3	Control, TS1, TS2

Number of observations 104

Tukey's Studentized Range (HSD) Test for TESTs

NOTE: This test controls the Type I experimentwise error rate.

Alpha	0.05	Error Mean Square	0.48076
Error Degrees of Freedom	101	Critical Value of Studentized Range	3.36410

Comparisons significant at the 0.05 level are indicated by ***.

Group	Difference	Simultaneous95%
<u>Comparison</u>	<u>Between Means</u>	<u>Confidence Limits</u>
Control - TS2	0.4333	0.0075 0.8592 ***
Control - TS1	0.5771	0.1512 1.0029 ***
TS2 - Control	-0.4333	-0.8592 -0.0075 ***
TS2 - TS1	0.1438	-0.2251 0.5126
TS1 - Control	-0.5771	-1.0029 -0.1512 ***
TS1 - TS2	-0.1438	-0.5126 0.2251



Control Section



Test Section one



Test Section Two

Project Analysis

This section of the report will summarize visual, ARAN and FWD tests on each treatment within the project.

Project Structural Comparison

To monitor stability of each roadway treatment, the FWD collected deflection readings on July 16, 2002 as close as possible to the preliminary test sites tested on July 24, 2000. To corroborate how well each treatment has increased roadway stability, a comparison of Pre Construction (2000), Future Traffic, Theoretical, and Post Construction (2002) Structural Numbers is presented in Table 12.

A Theoretical Structural Number (TSN) was calculated for each test site using layer coefficient values, Structural Numbers and existing material layer depths from Table 4 of the Construction Report, and material layer depths from typical design cross sections (Figure 2 thru 5 of the Construction Report). The following equations were used for each treatment:

HMA Overlay (Shim); $TSN = SN_e + (D_{sh} * C_{sh}) + (D_s * C_s)$

Full Depth Reclamation; $TSN = (D_{pg} - D_c) * C_g + D_c * C_c + D_b * C_b + D_s * C_s$

Full Depth Reclamation with Variable Depth Gravel;
 $TSN = (D_{pg} - D_c) * C_g + D_c * C_c + D_g * C_g + D_b * C_b + D_s * C_s$

Full Depth Reconstruction; $TSN = D_g * C_g + D_b * C_b + D_s * C_s$

Foamed Asphalt Stabilized Base; $TSN = (D_{pg} - D_c) * C_g + D_f * C_f + D_b * C_b + D_s * C_s$

Foamed Asphalt Stabilized Base without HMA Base; $TSN = (D_{pg} - D_c) * C_g + D_f * C_f + D_s * C_s$

Where;

SN_e = Existing structural number

D_{pg} = Depth of combined pavement and gravel (from Table 1)

C_g = Layer coefficient of Subbase Gravel, ASCG or VDG = 0.09

D_{sh} = Depth of HMA Shim (used an average of 35 mm based on total quantity of shim used on project)

C_{sh} = Layer coefficient of HMA Shim = 0.35

D_s = Depth of HMA Surface

C_s = Layer coefficient of HMA Surface = 0.44

D_c = Depth of Full Depth Reclaimed material

C_c = Layer coefficient of Full Depth Reclaimed material = 0.14

D_b = Depth of HMA Base

C_b = Layer coefficient of HMA Base = 0.40

D_g = Depth of ASCG or VDG (used an average of 360 mm for VDG)

D_f = Depth of Foamed Asphalt Stabilized Base

C_f = Layer coefficient of Foamed Asphalt Stabilized Base = 0.34

Theoretical and Post Construction (2002) Structural Number Comparisons

Theoretical Structural Numbers for the Full Depth Rehabilitation (C), Foamed Asphalt (F and F2) and Shim (S) sections correlate well with post construction 2002 Structural Numbers. This reassures accuracy of layer coefficient values used in calculations.

Comparisons for the Full Depth Reconstruction (R) and Variable Depth Gravel (V) sections are not as similar. Theoretical Structural Numbers are as accurate as layer depth information provided by subsurface explorations prior to construction and depth of aggregate subbase material placed at each of these test sites. Most of the reconstructed sections were on superelevated curve areas where the existing subbase material may not have been removed down to subgrade and the layer depth of aggregate subbase material used to raise the roadway to desired elevation and grade could be greater than 650mm (25 in). For the Variable Depth Gravel sections, this could be due to the variable thickness of the aggregate subbase material used during construction. An average thickness of 360 mm (14 in) was used to calculate the TSN when in fact there could be as much as 650 mm (25 in) of material.

Future Traffic and Post Construction (2002) Structural Number Comparisons

A majority of the post construction 2002 Structural Numbers are higher than the Future Traffic SN which indicates that the roadway is built to withstand projected levels of axle load traffic over a twenty year period.

Areas that show less than adequate strength include Shim treatments (S) from station 4+400 to 4+800 and 9+800 to 10+700 and Foamed Asphalt (F and F2) treatments from station 4+900 to 5+500 and 8+800 to 9+300.

Shim area treatments consist of an average of 35 mm (1.4 in) of HMA shim plus 40 mm (1.6 in) of HMA surface for a total average pavement thickness of 75 mm (3 in). Although this treatment has a ten year lifespan combined with the existing pavement it should provide adequate stability for the twenty year design criteria. Preliminary FWD data from Table 1 of the Construction Report recommended pavement thicknesses greater than 75 mm (3 in) in many of these areas to increase structural integrity to desired design criteria. All Shim areas that had a Recommended Pavement Thickness of 75 mm (3 in) or greater, with one exception at station 10+700 which had a recommended thickness of 68 mm (2.7 in), have less than adequate Structural Numbers in 2002. Additional pavement is necessary in these areas to increase roadway strength to a twenty year design lifespan.

Foamed Asphalt treatments between station 4+900 and 5+500 have less than adequate 2002 Structural Numbers due to a combined pavement gravel depth of 300 mm (12 in) on top of subgrade material with low resilient modulus values. Failing 2002 Structural Numbers between station 8+800 and 9+300 are due to the exclusion of 40 mm (1.5 in) of HMA base. Although the total pavement thickness has been reduced, the 2002 Structural Numbers are very close (within ten numbers) to the Future Traffic Structural Number.

Interim reports will compare 2002 FWD Structural Number to future Structural Numbers to determine the rate of structural degradation over time for each treatment.

Project Ride Analysis

A visual inspection of the project was conducted on March 5, 2002 to locate frost movement within the project. Two small areas had frost action, one at Station 1+580 and another at Station 1+860. Station 1+580 is located in a Full Depth Reconstruction portion of the project and the other is in a section of Foamed Asphalt. These areas will be monitored to determine if the HMA has deteriorated due to frost movement.

ARAN data was utilized to compare smoothness of each treatment from station 1+200 to 11+200. Table 13 contains a summary of the results.

The average IRI for all sections ranges between a low of 0.97 and high of 1.33 meters/kilometer.

Variable Depth Gravel sections (SURF/60B/FDRVDG) between stations 2+795 to 3+460, 3+820 to 4+000, and 4+205 to 4+380 have the lowest average IRI value at 0.97 m/km.

Shim areas (SURF/SHIM) between stations 1+200 to 1+400, 2+680 to 2+795, 4+380 to 4+900, 6+860 to 7+600, and 9+520 to 11+200 and Foamed Asphalt with Crusher Dust plus HMA surface and base (SURF/40B/FDRBS) between stations 1+640 to 2+680, 4+900 to 6+445, 6+525 to 6+860, and 7+600 to 8+720 have similar average IRI readings of 1.03 and 1.07 m/km respectively.

Table 12 Project Level Structural Number Comparison

Station	Treat- ment ⁵	2000 SN	Future Traffic SN	Theo- retical SN ⁶	2002 SN ⁶	Station	Treat- Ment ⁵	2000 SN	Future Traffic SN	Theo- retical SN ⁶	2002 SN ⁶	Station	Treat- Ment ⁵	2000 SN	Future Traffic SN	Theo- retical SN ⁶	2002 SN ⁶
1+200	S	91	110	121	122	4+600	S	67	106	97	96	8+000	F	88	109	134	131
1+300	S	78	127	108	121	4+700	S	64	104	94	88	8+100	F	89	101	134	124
1+400	C	78	118	85	123	4+800	S	67	100	97	90	8+200	F	93	102	134	123
1+500	R	74	123	100	147	4+900	F	58	131	128	117	8+300	F	80	120	134	117
1+600	R	75	117	100	159	5+000	F	58	134	128	108	8+400	F	88	115	134	129
1+700	F	71	122	134	138	5+100	F	56	133	128	111	8+500	F	81	109	134	122
1+800	F	64	109	128	98	5+200	F	56	130	128	101	8+600	F	88	111	134	147
1+900	F	78	115	128	122	5+300	F	78	128	128	118	8+700	F	82	105	134	126
2+000	F	71	126	128	112	5+400	F	63	126	128	101	8+800	F2	85	118	118	108
2+100	F	67	127	128	111	5+500	F	62	130	128	112	8+900	F2	83	115	118	109
2+200	F	73	117	128	101	5+600	F	80	120	141	140	9+000	F2	89	104	118	114
2+300	F	67	118	128	124	5+700	F	73	134	141	144	9+100	F2	76	110	118	100
2+400	F	85	108	150	144	5+800	F	82	115	141	136	9+200	F2	80	117	118	108
2+500	F	107	102	150	175	5+900	F	81	122	141	127	9+300	F2	87	107	118	103
2+600	F	87	102	150	165	6+000	F	68	140	141	123	9+400	F2	95	101	118	109
2+700	S	94	99	124	144	6+100	F	71	136	141	124	9+500	F2	77	99	118	126
2+800	V	88	109	134	154	6+200	F	75	125	141	134	9+600	S	73	114	103	98
2+900	V	97	116	134	164	6+300	F	79	113	141	133	9+700	S	83	92	113	98
3+000	V	96	120	134	161	6+400	F	82	102	141	123	9+800	S	76	116	106	101
3+100	V	48	140	111	148	6+500	F	76	128	141	132	9+900	S	77	115	107	101
3+200	V	57	128	111	153	6+600	F	82	107	141	128	10+000	S	79	114	109	102
3+300	V	57	143	111	128	6+700	F	89	102	141	132	10+100	S	76	111	106	102
3+400	V	59	126	111	150	6+800	F	91	94	141	145	10+200	S	76	111	106	101
3+500	R	75	120	100	139	6+900	S	96	99	126	117	10+300	S	69	121	99	92
3+600	C	60	118	79	90	7+000	S	98	106	128	124	10+400	S	72	120	102	101
3+700	R	60	126	100	137	7+100	S	88	92	118	117	10+500	S	71	119	101	92
3+800	C	62	117	79	85	7+200	S	97	103	127	122	10+600	S	82	117	112	102
3+900	V	55	139	111	150	7+300	S	76	131	106	107	10+700	S	83	113	113	107
4+000	V	76	118	111	154	7+400	S	91	108	121	124	10+800	S	83	101	113	104
4+100	C	55	138	79	88	7+500	S	92	94	122	116	10+900	S	85	108	115	109
4+200	R	52	134	100	147	7+600	F	96	104	134	130	11+000	S	84	107	114	106
4+300	V	59	139	111	141	7+700	F	78	121	134	129	11+100	S	105	108	135	126
4+400	S	61	102	91	90	7+800	F	82	117	134	137	11+200	S	97	107	127	130
4+500	S	64	103	94	92	7+900	F	88	109	134	126						

⁵ C = Full Depth Rehabilitation, F = Foamed Asphalt, F2 = Foamed Asphalt without HMA Base, R = Full Depth Reconstruction, S = Shim, V = "C" + Variable Depth Gravel

⁶ Bold numbers represent values that are lower than required Future Traffic Structural Number

The section constructed with Foamed Asphalt, HMA surface, HMA base with no crusher dust (SURF/40B/FDRBS/NCD) between stations 6+445 and 6+525 has an average IRI value of 1.14.

Full Depth Reclamation sections (SURF/60B/FDR) between stations 1+400 to 1+490, 3+527 to 3+600, 3+700 to 3+820, and 4+000 to 4+130 and Full Depth Reconstruction sections (SURF/60B/RECON)

between stations 1+490 to 1+640, 3+400 to 3+527, 3+600 to 3+700, and 4+130 to 4+205 have similar average IRI values of 1.25 and 1.26 m/km respectively.

Foamed Asphalt section with 40 mm of HMA Surface and no HMA Base (SURF/FDRBS) between stations 8+720 and 9+520 has the highest average IRI value of 1.33 m/km.

Based on IRI descriptions in Table 7, the project has a smooth ride after one year's exposure to traffic.

Table 13 Project Level IRI Summary

Treatment	High IRI	Low IRI	Avg. IRI*	Count	SD
SURF/SHIM	2.50	0.60	1.03	652	0.273
SURF/60B/FDR (Control)	2.91	0.80	1.25	88	0.452
SURF/60B/RECON	2.75	0.80	1.26	72	0.432
SURF/40B/FDRBS (Test Section 1)	2.42	0.59	1.07	802	0.249
SURF/40B/FDRBS/NCD	1.71	0.97	1.14	16	0.206
SURF/FDRBS (Test Section 2)	3.05	0.78	1.33	160	0.413
SURF/60B/FDRVDG	1.77	0.60	0.97	204	0.221

*High IRI indicates a rougher ride

A statistical comparison of each treatment using ARAN Ride data is displayed in Table 14. Treatments that are significantly different at the 95% confidence level are summarized below.

Areas treated with Foamed Asphalt and HMA surface with no HMA base had the highest average IRI. Three roadway treatments have significantly lower average IRI values than this treatment, Foamed Asphalt with HMA surface and HMA base, shim plus HMA surface, and Full Depth Reclamation with variable depth gravel.

Full Depth Reconstructed areas also have high IRI values. Treatments that were significantly smoother include Foamed Asphalt with HMA surface and HMA base, shim plus HMA surface, and Full Depth Reclamation with variable depth gravel.

Full Depth Reclamation with no Bituminous Stabilizer has a high average IRI value at 1.25. Three treatments had significantly lower mean IRI values, they include; Foamed Asphalt with HMA surface and HMA base, shim plus HMA surface, and Full Depth Reclamation with variable depth gravel.

The Foamed Asphalt section with no crusher dust has mean IRI values at the median of the range of values. There were no treatments significantly higher or lower than this treatment.

Foamed Asphalt with Bituminous base and surface has a mean IRI within the low range of values. Three treatments have significantly higher IRI values than this treatment and one treatment has a significantly lower mean value. The three higher treatments include; Foamed Asphalt with no HMA base, Full Depth Reconstructed, and Full Depth Reclamation with no stabilizer. The treatment with a significantly lower mean IRI value is Full Depth Reclamation with variable depth gravel.

Table 14 Project Level Statistical Analysis of IRI Measurements

The SAS System
The GLM Procedure

Class Level Information

Class	Levels	Values
Group	7	SURF/SHIM, SURF/60B/FDR, SURF/60B/RECON, SURF/40B/FDRBS, SURF/40B/FDRBS/NCD, SURF/FDRBS, SURF/60B/FDRVDG

Number of observations 1994

Tukey's Studentized Range (HSD) Test for TESTs
NOTE: This test controls the Type I experimentwise error rate.

Alpha	0.05	Error Mean Square	0.083899
Error Degrees of Freedom	1987	Critical Value of Studentized Range	4.17387

Comparisons significant at the 0.05 level are indicated by ***.

Group	Difference	Simultaneous 95%
<u>Comparison</u>	<u>Between Means</u>	<u>Confidence Limits</u>
SURF/FDRBS - SURF/60B/RECON	0.06549	-0.05583 0.18680
SURF/FDRBS - SURF/60B/FDR	0.07733	-0.03613 0.19078
SURF/FDRBS - SURF/40B/FDRBS/NCD	0.18625	-0.03790 0.41040
SURF/FDRBS - SURF/40B/FDRBS	0.25974	0.18572 0.33376 ***
SURF/FDRBS - SURF/SHIM	0.29450	0.21908 0.36992 ***
SURF/FDRBS - SURF/60B/FDRVDG	0.35482	0.26454 0.44509 ***
SURF/60B/RECON - SURF/FDRBS	-0.06549	-0.18680 0.05583
SURF/60B/RECON - SURF/60B/FDR	0.01184	-0.12400 0.14769
SURF/60B/RECON - SURF/40B/FDRBS/NCD	0.12076	-0.11551 0.35704
SURF/60B/RECON - SURF/40B/FDRBS	0.19425	0.08908 0.29942 ***
SURF/60B/RECON - SURF/SHIM	0.22901	0.12285 0.33518 ***
SURF/60B/RECON - SURF/60B/FDRVDG	0.28933	0.17214 0.40652 ***
SURF/60B/FDR - SURF/FDRBS	-0.07733	-0.19078 0.03613
SURF/60B/FDR - SURF/60B/RECON	-0.01184	-0.14769 0.12400
SURF/60B/FDR - SURF/40B/FDRBS/NCD	0.10892	-0.12342 0.34126
SURF/60B/FDR - SURF/40B/FDRBS	0.18241	0.08641 0.27841 ***
SURF/60B/FDR - SURF/SHIM	0.21717	0.12008 0.31425 ***
SURF/60B/FDR - SURF/60B/FDRVDG	0.27749	0.16846 0.38651 ***
SURF/40B/FDRBS/NCD - SURF/FDRBS	-0.18625	-0.41040 0.03790
SURF/40B/FDRBS/NCD - SURF/60B/RECON	-0.12076	-0.35704 0.11551
SURF/40B/FDRBS/NCD - SURF/60B/FDR	-0.10892	-0.34126 0.12342
SURF/40B/FDRBS/NCD - SURF/40B/FDRBS	0.07349	-0.14235 0.28933
SURF/40B/FDRBS/NCD - SURF/SHIM	0.10825	-0.10808 0.32457
SURF/40B/FDRBS/NCD - SURF/60B/FDRVDG	0.16857	-0.05337 0.39051
SURF/40B/FDRBS - SURF/FDRBS	-0.25974	-0.33376 -0.18572 ***
SURF/40B/FDRBS - SURF/60B/RECON	-0.19425	-0.29942 -0.08908 ***
SURF/40B/FDRBS - SURF/60B/FDR	-0.18241	-0.27841 -0.08641 ***
SURF/40B/FDRBS - SURF/40B/FDRBS/NCD	-0.07349	-0.28933 0.14235
SURF/40B/FDRBS - SURF/SHIM	0.03476	-0.01032 0.07984
SURF/40B/FDRBS - SURF/60B/FDRVDG	0.09508	0.02805 0.16211 ***
SURF/SHIM - SURF/FDRBS	-0.29450	-0.36992 -0.21908 ***
SURF/SHIM - SURF/60B/RECON	-0.22901	-0.33518 -0.12285 ***
SURF/SHIM - SURF/60B/FDR	-0.21717	-0.31425 -0.12008 ***
SURF/SHIM - SURF/40B/FDRBS/NCD	-0.10825	-0.32457 0.10808
SURF/SHIM - SURF/40B/FDRBS	-0.03476	-0.07984 0.01032
SURF/SHIM - SURF/60B/FDRVDG	0.06032	-0.00826 0.12890
SURF/60B/FDRVDG - SURF/FDRBS	-0.35482	-0.44509 -0.26454 ***
SURF/60B/FDRVDG - SURF/60B/RECON	-0.28933	-0.40652 -0.17214 ***
SURF/60B/FDRVDG - SURF/60B/FDR	-0.27749	-0.38651 -0.16846 ***
SURF/60B/FDRVDG - SURF/40B/FDRBS/NCD	-0.16857	-0.39051 0.05337
SURF/60B/FDRVDG - SURF/40B/FDRBS	-0.09508	-0.16211 -0.02805 ***
SURF/60B/FDRVDG - SURF/SHIM	-0.06032	-0.12890 0.00826

Shim plus HMA surface treatments are also in the lower mean IRI range. Treatments that have significantly higher mean IRI values include; Foamed Asphalt with no HMA base, Full Depth Reconstruction and Full Depth Reclamation with no bituminous stabilizer.

Full Depth Reclamation with Variable Depth Gravel treatments has the lowest mean IRI value. Four treatments have significantly higher mean IRI values, Foamed Asphalt with no HMA base, Full Depth Reconstructed, Full Depth Reclamation with no bituminous stabilizer, and Foamed Asphalt with HMA surface and base.

Project Rut Depth Analysis

The ARAN was utilized to measure ruts depths in each wheel path at 20 meter intervals from station 1+200 to 11+200. Table 15 contains a summary of test results for each treatment.

Average Rut Depths for each treatment range from a low of 4.66 mm (0.18 in) to a high of 5.53 mm (0.22 in).

Table 15 Project Level Rut Depth Summary

Treatment	High Rut (mm)	Low Rut (mm)	Avg. Rut (mm)	Count	SD
SURF/SHIM	8.50	3.25	4.80	652	0.639
SURF/60B/FDR	9.00	4.00	5.53	88	1.018
SURF/60B/RECON	7.25	3.50	4.93	72	0.686
SURF/40B/FDRBS	10.50	3.25	5.40	808	1.034
SURF/40B/FDRBS/NCD	5.50	3.75	4.66	16	0.499
SURF/FDRBS	9.25	3.75	5.11	160	0.833
SURF/60B/FDRVDG	8.00	3.75	4.90	204	0.818

Bituminous stabilized sections with no crusher dust have the lowest average rut depth and sections treated with Full Depth Reclamation have the highest average rut depth. The depth of rutting is typical for a project exposed to traffic for one year.

To determine if a treatment has significantly higher or lower rut depth values, a comparison of each treatment was made using Tukey's Studentized Range statistical analysis tool. A summary of the results are displayed in Table 16.

Sections of the project that are treated with Full Depth Reclamation material with no bituminous stabilizer (SURF/60B/FDR) has significantly greater rutting than sections treated with SURF/FDRBS, SURF/60B/RECON, SURF/60B/FDRVDG, SURF/SHIM, and SURF/40B/FDRBS/NCD.

Foamed asphalt sections sealed with a total of 80 mm (3 in) of HMA (SURF/40B/FDRBS) has significantly greater rutting than the SURF/FDRBS, SURF/60B/RECON, SURF/60B/FDRVDG, SURF/SHIM, and SURF/40B/FDRBS/NCD sections.

Foamed Asphalt treated sections surfaced with a total of 40 mm (1.5 in) HMA (SURF/FDRBS) has significantly less rutting than the SURF/60B/FDR and SURF/40B/FDRBS sections but significantly greater rutting than the SURF/SHIM section.

Full Depth Reconstructed sections (SURF/60B/RECON) and variable depth gravel sections (SURF/60B/FDRVDG) have significantly less rutting than the SURF/60B/FDR and SURF/40B/FDRBS sections.

Table 16 Project Level Statistical Analysis of Rut Depth Measurements

The SAS System
The GLM Procedure

Class Level Information

Class	Levels	Values
Group	7	SURF/SHIM, SURF/60B/FDR, SURF/60B/RECON, SURF/40B/FDRBS, SURF/40B/FDRBS/NCD, SURF/FDRBS, SURF/60B/FDRVDG

Number of observations 2000

Tukey's Studentized Range (HSD) Test for TESTs
NOTE: This test controls the Type I experimentwise error rate.

Alpha	0.05	Error Mean Square	0.754175
Error Degrees of Freedom	1993	Critical Value of Studentized Range	4.17385

Comparisons significant at the 0.05 level are indicated by ***.

Group Comparison	Difference Between Means	Simultaneous 95% Confidence Limits
SURF/60B/FDR - SURF/40B/FDRBS	0.13372	-0.15400 0.42144
SURF/60B/FDR - SURF/FDRBS	0.42784	0.08768 0.76800 ***
SURF/60B/FDR - SURF/60B/RECON	0.60701	0.19971 1.01430 ***
SURF/60B/FDR - SURF/60B/FDRVDG	0.63703	0.31015 0.96392 ***
SURF/60B/FDR - SURF/SHIM	0.73041	0.43933 1.02149 ***
SURF/60B/FDR - SURF/40B/FDRBS/NCD	0.87784	0.18126 1.57442 ***
SURF/40B/FDRBS - SURF/60B/FDR	-0.13372	-0.42144 0.15400
SURF/40B/FDRBS - SURF/FDRBS	0.29412	0.07234 0.51591 ***
SURF/40B/FDRBS - SURF/60B/RECON	0.47329	0.15806 0.78852 ***
SURF/40B/FDRBS - SURF/60B/FDRVDG	0.50331	0.30248 0.70414 ***
SURF/40B/FDRBS - SURF/SHIM	0.59669	0.46176 0.73162 ***
SURF/40B/FDRBS - SURF/40B/FDRBS/NCD	0.74412	0.09704 1.39120 ***
SURF/FDRBS - SURF/60B/FDR	-0.42784	-0.76800 -0.08768 ***
SURF/FDRBS - SURF/40B/FDRBS	-0.29412	-0.51591 -0.07234 ***
SURF/FDRBS - SURF/60B/RECON	0.17917	-0.18456 0.54289
SURF/FDRBS - SURF/60B/FDRVDG	0.20919	-0.06147 0.47986
SURF/FDRBS - SURF/SHIM	0.30257	0.07644 0.52870 ***
SURF/FDRBS - SURF/40B/FDRBS/NCD	0.45000	-0.22204 1.12204
SURF/60B/RECON - SURF/60B/FDR	-0.60701	-1.01430 -0.19971 ***
SURF/60B/RECON - SURF/40B/FDRBS	-0.47329	-0.78852 -0.15806 ***
SURF/60B/RECON - SURF/FDRBS	-0.17917	-0.54289 0.18456
SURF/60B/RECON - SURF/60B/FDRVDG	0.03002	-0.32132 0.38137
SURF/60B/RECON - SURF/SHIM	0.12340	-0.19490 0.44170
SURF/60B/RECON - SURF/40B/FDRBS/NCD	0.27083	-0.43756 0.97922
SURF/60B/FDRVDG - SURF/60B/FDR	-0.63703	-0.96392 -0.31015 ***
SURF/60B/FDRVDG - SURF/40B/FDRBS	-0.50331	-0.70414 -0.30248 ***
SURF/60B/FDRVDG - SURF/FDRBS	-0.20919	-0.47986 0.06147
SURF/60B/FDRVDG - SURF/60B/RECON	-0.03002	-0.38137 0.32132
SURF/60B/FDRVDG - SURF/SHIM	0.09338	-0.11224 0.29899
SURF/60B/FDRVDG - SURF/40B/FDRBS/NCD	0.24081	-0.42461 0.90623
SURF/SHIM - SURF/60B/FDR	-0.73041	-1.02149 -0.43933 ***
SURF/SHIM - SURF/40B/FDRBS	-0.59669	-0.73162 -0.46176 ***
SURF/SHIM - SURF/FDRBS	-0.30257	-0.52870 -0.07644 ***
SURF/SHIM - SURF/60B/RECON	-0.12340	-0.44170 0.19490
SURF/SHIM - SURF/60B/FDRVDG	-0.09338	-0.29899 0.11224
SURF/SHIM - SURF/40B/FDRBS/NCD	0.14743	-0.50115 0.79601
SURF/40B/FDRBS/NCD - SURF/60B/FDR	-0.87784	-1.57442 -0.18126 ***
SURF/40B/FDRBS/NCD - SURF/40B/FDRBS	-0.74412	-1.39120 -0.09704 ***
SURF/40B/FDRBS/NCD - SURF/FDRBS	-0.45000	-1.12204 0.22204
SURF/40B/FDRBS/NCD - SURF/60B/RECON	-0.27083	-0.97922 0.43756
SURF/40B/FDRBS/NCD - SURF/60B/FDRVDG	-0.24081	-0.90623 0.42461
SURF/40B/FDRBS/NCD - SURF/SHIM	-0.14743	-0.79601 0.50115

Sections treated with HMA shim and surface (SURF/SHIM) has significantly less rutting than the SURF/60B/FDR, SURF/40B/FDRBS, and SURF/FDRBS sections.

Foamed Asphalt treated sections with no crusher dust (SURF/40B/FDRBS/NCD) has significantly lower rut depths than the SURF/60B/FDR and SURF/40B/FDRBS sections.

Summary

After one year of traffic the project as a whole is performing very well. Prior to construction, the project had a high incidence of frost movement and severe rutting. Frost movement and rutting has been significantly reduced along the entire project.

After the Department cut core samples from Foamed Asphalt sections of the project, it was apparent that large stone or reclaim material, greater than 25mm diameter, reduced structural integrity of the bituminous stabilized base material. Wirtgen representatives confirmed this and added that it is important that there be enough fine material in the mix to supply enough surface area for the expanded asphalt. This will increase stability and the material will be easier to work with.

Many areas of the project that were treated with shim and surface only did not meet the Future Traffic Structural Number generated by FWD tests. These areas will be monitored closely for premature deterioration.

Sections treated with Foamed Asphalt and 80 mm (3 in) of HMA (Test Section 1) have a smoother ride than Foamed Asphalt treated sections with 40 mm (1.5 in) of HMA (Test Section 2) and the Control Section. This treatment also rides better than most of the other treatments within the project.

Both Foamed Asphalt treated sections have less rutting than the Control Section. Test Section 1 has less rutting than Test Section 2 possibly due to the reduced amount of HMA surface on Test Section 2. On a project level comparison, the Foamed Asphalt section with no crusher dust has the least amount of rutting and the other two Foamed Asphalt treated areas have some of the highest rutting. Future inspections will determine if rutting stabilizes within the Foamed Asphalt treated sections.

A statistical comparison of treatments using FWD data was not made due to the number of variables within each treatment, such as depth of subbase and depth of HMA, making a valid comparison very difficult. The rate of structural degradation for each treatment can be monitored to determine which treatment efficiently bears traffic with time.

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Additional Documentation:
“Using Foamed Asphalt as a Stabilizing Agent in Full Depth Reclamation of Route 8 in Belgrade”,
Construction Report # 02-2, February 2002